



## More about IMD

IMD stands for Intermodulation Distortion. IMD is created when two or more audio tones beat with one another (intermodulate) in a non-linear device to produce undesired new tones. The primary mechanism producing IM in most devices is AM (amplitude modulation), which creates sidebands that are at the sum and difference of the frequencies of the original audio tones.

For example, if a 2 kHz audio tone and a 7 kHz audio tone pass through a non-linear device and undergo AM intermodulation distortion, the output signal will contain new tones (modulation products) at 9 kHz (the sum of the tones) and at 5 kHz (the difference of the tones).

The modulation products may also beat with each other and with the original audio signal, creating more modulation products.

Measurements that have two tones in the stimulus are used to measure IMD.

IMD measurements in APx500 include

### **SMPTE (DIN)**

SMPTE IMD is a technique for measuring IMD (intermodulation distortion) according to the SMPTE RP120-1983 standard. The DIN intermodulation distortion technique uses a similar method.

The stimulus is a strong low-frequency interfering signal ( $f_1$ ) combined with a weaker high frequency signal of interest ( $f_2$ ).  $f_1$  is usually 60 Hz and  $f_2$  is usually 7 kHz, at a ratio of  $f_1/f_2=4:1$ . The stimulus signal is the sum of the two sine waves. In a distorting DUT, this stimulus results in an AM (amplitude modulated) waveform, with  $f_2$  as the “carrier” and  $f_1$  as the modulation.

In analysis,  $f_1$  is removed, and the residual is bandpass filtered and then demodulated to reveal the AM modulation products. The rms level of the modulation products is

measured and expressed as a ratio to the rms level of f2. The SMPTE IMD measurement includes noise within the passband, and is insensitive to FM (frequency modulation) distortion.

The APx500 implementation of SMPTE IMD provides the capability to vary the stimulus frequencies and to choose a 1:1 stimulus ratio.

## **MOD**

MOD IMD is similar to SMPTE IMD, and in some cases produces the same results. The MOD stimulus is the same as the SMPTE stimulus, but instead of using AM demodulation for analysis MOD selectively measures the 2nd and 3rd order intermodulation products and combines their values arithmetically. This method reduces the influence of noise in the result, and is sensitive to any distortion mechanism. When only amplitude modulation IMD exists, and when noise is very low, the MOD results will be identical to the SMPTE results.

The APx500 implementation of MOD IMD provides the capability to vary the stimulus frequencies, choose additional stimulus ratios and to display additional intermodulation products.

## **DFD**

DFD stands for Difference Frequency Distortion. DFD is described in the standards IEC60118 and IEC60268.

The DFD stimulus is two equal-level high-frequency tones f1 and f2, centered around a frequency called the mean frequency,  $(f1+f2)/2$ . The tones are separated by a frequency offset called the difference frequency. The two tones intermodulate in a distorting DUT to produce sum and difference frequencies.

For analysis DFD selectively measures the 2nd and 3rd order intermodulation products, combines their values arithmetically and provides a result that is the ratio of the sum of the products to a reference voltage defined as 2x the voltage of f2 (effectively, the sum of f1 and f2). In the APx500 implementation, the 4th and 5th order products are also measured and reported in the distortion product view.

Because the stimulus tones are high in frequency, DFD is a useful measurement for observing distortion in devices that exhibit distortion that rises with frequency. Since the tones by default are only 80 Hz apart, much of the energy contained in the distortion products will fall near or below the stimulus tones. This makes DFD a good choice for measuring distortion at higher frequencies in band limited devices, where harmonic distortion products from high-frequency stimulus tones would fall out of band.

DFD measurements are made in the same way as CCIF measurements, differing only in amplitude calibration. DFD results are expressed as values 6.02 dB lower than CCIF.

## **CCIF (IMD ITU-R)**

The CCIF IMD method is described in document no. 11 of the Commission Mixte, CCIF/UIR, March 1937, issued by the International Telephonic Consultative Committee

(CCIF). CCIF no longer exists as an organization, having become the ITU-R division of the International Telecommunications Union (ITU). This method is also referred to as IMD (ITU-R).

The CCIF stimulus is two equal-level high-frequency tones  $f_1$  and  $f_2$ , centered around a frequency called the mean frequency,  $(f_1+f_2)/2$ . The tones are separated by a frequency offset called the difference frequency. The two tones intermodulate in a distorting DUT to produce sum and difference frequencies.

For analysis CCIF selectively measures the 2nd and 3rd order intermodulation products, combines their values arithmetically and provides a result that is the ratio of the sum of the products to a reference voltage defined as 2x the voltage of  $f_2$  (effectively, the sum of  $f_1$  and  $f_2$ ). In the APx500 implementation, the 4th and 5th order products are also measured and reported in the distortion product view.

Because the stimulus tones are high in frequency, CCIF is a useful measurement for observing distortion in devices that exhibit distortion that rises with frequency. Since the tones by default are only 80 Hz apart, much of the energy contained in the distortion products will fall near or below the stimulus tones. This makes CCIF a good choice for measuring distortion at higher frequencies in band limited devices, where harmonic distortion products from high-frequency stimulus tones would fall out of band.

CCIF measurements are made in the same way as DFD measurements, differing only in amplitude calibration. CCIF results are expressed as values 6.02 dB higher than DFD.